Vacancies and recruitment of new employees

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Published in:
Journal of Labor Economics

Publication date:
1992

Vacancies and the Recruitment of New Employees

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Little is known about the search strategy that employers use in their efforts to fill job vacancies. In this article, we analyze unique micro data to study this search strategy. We conclude that almost all vacancies are filled from a pool of applicants that is formed shortly after the posting of the vacancy. Hence, vacancy durations should be interpreted as selection periods and not as search periods for applicants.

I. Introduction

In the past decade economists have made considerable progress in the study of unemployment durations. First, search theory, which has its roots in the sixties (Stigler 1961), was developed into a coherent theoretical framework for models of unemployment spells.[1] Second, the introduction of hazard models provided economists with the statistical tools to answer important questions concerning unemployment durations.[2] These developments are closely related. On the one hand, job search theory predicts how the reemployment probability of an unemployed worker is affected by the constraints that he or she faces, for example, the offer arrival rate, the wage offer distribution, the level of unemployment benefits, and the (dis)utility of unemployment. On the other hand, hazard models of unemployment durations specify how the reemployment probability depends on characteristics of the unemployed worker and his or her environment and on the elapsed duration of unemployment. Ideally, an empirical hazard

We would like to thank the Organization for Strategic Labor Market Research for the use of vacancy data and for financial support.

[1] Mortensen (1986) is an excellent survey of job search theory.

[2] For an introduction into hazard models, see Kiefer (1988).

[*Journal of Labor Economics*, 1992, vol. 10, no. 2]

0734-306X/92/1002-0003$01.50

specification should be derived from a job search model. Most empirical hazard models do not incorporate all the restrictions implied by job search theory,[3] but even reduced-form hazard models are interpreted in the light of job search theory. Building realistic empirical models of job search that incorporate the restrictions of job search theory and that allow for a direct test of this theory is still a major challenge.

The progress in the study of job search by the unemployed has not been matched by progress in the study of the search for employees by employers. This is unfortunate, because the performance of the labor market, as measured by the rate at which matches between job seekers and searching employers are formed, can only be evaluated by considering both unemployment and vacancy durations (Blanchard and Diamond 1989; Jackman, Layard, and Pissarides 1989). After the pioneering study by Holt and David (1966), surprisingly little work has been done on employer search. Barron and Bishop (1985) and Barron, Bishop, and Dunkelberg (1985) study employer search by relating the number of applicants or interviews per employment offer and the time spent on recruiting and screening per applicant or per interview to characteristics of the vacancy and the employer. Their work can be seen as a direct study of various measures of the search intensity with which employers look for a suitable employee. They are silent on the outcome of the search effort; that is, they do not study how long it takes to find a suitable employee and what his or her characteristics are. Beaumont (1978), Roper (1988), Renes (1989), and van Ours (1989) study vacancy durations; that is, they consider only the outcome of the search effort of the employers.[4] They relate the vacancy duration to various characteristics of the vacancy and the employer. Renes and van Ours, who use hazard models, also address the question how the rate at which vacancies are filled depends on the elapsed duration of the vacancy.

In this article we shall use data on vacancy durations and the number of applicants to study the search strategy of employers. By combining these data we are able to separately identify the arrival rate of applicants and the acceptance probability of these applicants. We shall test whether

[3] Exceptions are Narendranathan and Nickell (1985), Wolpin (1987), Stern (1989), and Van den Berg (1990). Recently, Eckstein and Wolpin (1990) estimated a structural search model with an endogenous wage offer distribution. In their model, employers set wages to maximize profits, taking account of the lower acceptance probability of relatively low wages. They implicitly assume that employers hire all workers that accept their wage offer. This is a consequence of the linear technology assumed by these authors. We take a different position: employers announce vacancies and hire one person per position. See Stern (1990) for another search model with wage-setting employers.

[4] Renes (1989) and van Ours (1989) use Organization for Strategic Labor Market Research (OSA) data, as do we.

the sequential search model that has been the dominant model for search by the unemployed is an appropriate model for the recruitment behavior of employers. In the sequential search model, applicants arrive sequentially at the firm and are accepted or rejected on arrival. Such a model for employer search has been proposed by Lippman and McCall (1976) and other authors.

The plan of the article is as follows. In Section II we discuss models of employer search and compare them with models of search by the unemployed. In Section III we introduce a model for the joint determination of vacancy durations and numbers of applicants. Section IV describes the data, and the estimation results are in Section V. Section VI concludes.

II. Vacancies and Employer Search

Firms have vacancies because it takes time to find a suitable employee for a specific job. Jobs usually require specific skills, and only some job seekers may have these skills. Moreover, employers may need formal or informal tests to assess whether an applicant has the required skills. It takes time to attract applicants and to decide whether they are suitable. In most surveys a vacancy is defined as a slot that an employer would like to fill *immediately*. Hence, the existence of vacancies implies that employers do not have perfect control over the hiring of new employees. They are faced with uncertainty over the time at which a suitable applicant can be hired and over the characteristics of the new employee.

Of course, an employer can take measures to reduce this uncertainty. Most jobs have periods of notice that allow the employer to start searching and hiring before the present employee has left. This strategy is not very successful. In January 1988, 68% of all vacancies in the Netherlands referred to unoccupied jobs (Central Bureau of Statistics, Vacancy Survey 1988).[5] There may be a good reason for this. Advance hiring of employees involves paying double wages, and this is an expensive way to avoid the costs of an unoccupied position. Advertising and using the services of a personnel department are other means to reduce the uncertainty regarding the time of hiring and the skills of the new employee. These efforts are quite effective. In the eighties the vacancy rate—that is, the ratio of the number of vacancies to the number of employees—in the Netherlands varied between 0.4% in 1982 and 1.6% in 1988. In the same period, the average complete vacancy duration varied between 2.1 months in 1980 and 0.9 months in 1983 (1988,

[5] It is interesting to note that this number is larger for small (<10 employees) firms, 74%, than for medium sized (10–49 employees) and large (>49 employees), 65% and 46%, respectively. Large firms have a more predictable outflow of employees and more possibilities for advance hiring. Note also that we report percentages of the stock of vacancies and that a larger fraction of the vacancies that are filled in a specific period may still be occupied at the time of hiring.

1.3 months).[6] Hence, even if the employers do not have full control over the time of hiring, they do not miss many employees due to vacancies (0.1%–0.5% of all employees). Moreover, it does not take long to find a suitable employee. This does not mean that vacancies are uncommon: the number of vacancies generated in a year varied between 15% of the employed in 1987 and 5% in 1982. Hence, most jobs are presumably filled after a vacancy, that is, after a search period.

In the extensive literature on job search by the unemployed, it is usually assumed that the unemployed use a sequential search strategy. Job offers arrive (or are discovered) according to a point process—for example, a Poisson process. A job offer is a draw from a wage offer distribution. On arrival of the job offer, the unemployed individual has to decide whether to accept the job or not. The optimal decision strategy maximizes the searcher's expected discounted utility stream. The optimal strategy depends on knowledge of the wage offer distribution and the arrival rate of jobs, the (non)stationarity of the search environment, the form of the utility function, the possibility of recall (or not), and the time horizon of the searcher. Under certain assumptions (e.g., known arrival rate and wage offer distribution, monotonic, additive utility, no recall, and infinite time horizon) the optimal search strategy is characterized by a reservation wage. This reservation wage depends on the arrival rate, the search costs, and the parameters of the wage offer distribution. The probability that a randomly chosen job is acceptable depends on the same variables.

The probability that an unemployed job seeker finds a job in some small time interval, given that he or she is still unemployed at the start of that interval—that is, the hazard rate of leaving unemployment (for a job)—is equal to the product of the arrival rate of job offers and the acceptance probability.

We can build a similar model for search by employers, and indeed Lippman and McCall (1976, p. 182) present such a model.[7] A more sophisticated

[6] There is a substantial variation in these numbers with the required level of education and the type of job (van Ours and Ridder 1991*a*). Furthermore, the variation in the vacancy duration in relation to the variation in the unemployment duration may be more interesting than the order of magnitude (Blanchard and Diamond 1989; Jackman et al. 1989).

[7] Lippman and McCall (1976) assume that, for given wage offers, employers searching for new employees face a distribution of marginal products. Their model of employer search is a variant of the elementary job search model with marginal products replacing wages. We also assume given wage offers. We think that (at least Dutch) employers offer wages to entrants based on salary ranges connected to jobs. These salary ranges are rigidly used for incumbent workers as well as new employees. The wage offer to a specific worker—that is, the position within the salary range—is based on personal characteristics such as age, education, and experience. In these circumstances, employers cannot use the wage offer as an instrument.

version of their elementary employer search model is as follows. Applicants arrive according to a Poisson process at a firm. The firm screens these applicants in order to assess their likely contribution to the firm's profits. Screening involves costs. There may also be costs if the vacancy refers to an unoccupied job. The firm knows the arrival rate of applicants (but not their time of arrival) and the distribution of characteristics of potential applicants. The productivity of applicants is not directly observable. Instead the firm may use such observable characteristics as age, work experience, and educational level as screening devices, possibly supplemented by further tests to assess the productive capacity of the applicant. The optimal strategy, that is, the strategy that maximizes the expected present value of the flow of profits, specifies a reservation productivity or reservation values of observed productivity-related characteristics, that is, job requirements. These job requirements may also reflect the different productive skills required for heterogeneous jobs. In a companion paper (van Ours and Ridder 1991*b*), we analyze job requirements and their evolution over the duration of the vacancy. The analysis shows that the job requirements are not lowered if the vacancy remains open for a longer period, which suggests that the reservation productivity value does not decline over time.

In the sequential employer search model, the hazard rate of filling a vacancy is equal to the product of the arrival rate of applicants and the probability that an applicant is acceptable. In our empirical work, we shall use data on the number of applicants and the vacancy duration to identify both factors.

The results of our analysis are not compatible with the sequential search model. Instead, they indicate that employer search is nonsequential. Almost all applicants arrive in a short period just after the vacancy has been announced. Hence the firm seems to generate a large number of applicants early in the vacancy duration. This is most likely the result of advertising the vacancy in one or more newspapers (69% of all vacancies are advertised, and 80% of these advertised vacancies are only advertised once) or notifying the labor exchange or an employment agency. There are good reasons why employers prefer this strategy. It is well known that a compound strategy in which the searcher can generate more than one offer at some extra cost usually dominates a sequential strategy where offers come one at a time (see Gal, Landsberger, and Levykson 1981; and Morgan 1983). Hence advertising and screening the resulting pool of applicants is preferred over sequential search.

III. A Statistical Model of Vacancy Durations and the Number of Applicants

To study the recruitment strategy of employers, we use data on the duration of a vacancy and the number of applicants that contacted the firm during this period. Hence we need the joint distribution of these

random variables. We shall derive the distribution on the assumption of sequential search. However, if the true search strategy is nonsequential, the data are still compatible with a special case of our model. Hence, our model can be used to test whether employers use a sequential or a nonsequential strategy. We assume that applicants arrive at the firm according to a time-inhomogeneous Poisson process with arrival rate $m(t)$. On arrival these applicants are tested by the firm and immediately accepted or rejected. The probability that an applicant is suitable and is hired by the firm is equal to $P(t)$. Thus the arrival rate of unsuitable applicants is equal to $m_R(t) = m(t)[1 - P(t)]$, and the arrival rate of suitable applicants—that is, the rate at which the vacancy is filled or the hazard of filling the vacancy—is $m_A(t) = \theta(t) = m(t)P(t)$. The joint density of a vacancy duration t and $N(t) = n$ rejected applicants at t is equal to

$$f(n, t) = \theta(t)\exp\left[-\int_0^t \theta(s)ds\right]\exp[-M_R(t)]\frac{[M_R(t)]^n}{n!}, \quad n = 0, 1, \ldots \tag{1}$$

with

$$M_R(t) = \int_0^t m_R(s)ds. \tag{2}$$

The density in (1) is written as the product of the marginal density of t and the conditional density of $N(t)$ given the vacancy duration. Although this joint density is derived on the assumption of sequential search by the employers, we shall argue below that nonsequential search can be seen as a limiting case of this model.

The density in (1) is appropriate for the study of a cohort of vacancies. However, our data are obtained by sampling the stock of vacancies at a particular moment in time. It is well known (e.g., Ridder 1988) that using density (1) in the analysis of stock data yields biased estimates; for example, the average vacancy duration is larger in the stock than in the cohort. The appropriate density for the analysis of durations drawn from the stock takes account of the overrepresentation of long durations in the stock.

Let us distinguish between calendar time τ and duration time t. Hence, if a vacancy that was posted at time τ has lasted a period t, then the calendar time is $\tau + t$. The rate at which vacancies are announced is denoted by $q(\tau)$. This rate will vary with the calendar time. It is convenient to put the time origin at the date that the stock was sampled. A vacancy can be included in the sample if it was announced at some date $-t$ and has lasted for at least a period t—that is, if it still exists at the date of sampling. Hence, the density of an incomplete vacancy duration t_1 at time 0 is

$$g_1(t_1) = \frac{q(-t_1)\exp\left[-\int_0^{t_1}\theta(s)ds\right]}{\int_0^{\infty} q(-t)\exp\left[-\int_0^{t}\theta(s)ds\right]dt}. \tag{3}$$

The sample is drawn, not from the stock of vacancies, but from the stock of firms. Only those firms were included that had a vacancy at the date of sampling. We can analyze this sample as a sample from the stock of vacancies if we assume that vacancies are announced and filled independently of each other—that is, there are no unobserved employer-specific effects. In (3) we assume implicitly that the hazard θ does not depend on calendar time.

The joint density of the incomplete vacancy duration and the number of applicants at the date of interview are

$$g_2(t_1, n) = g_1(t_1)\exp[-M_R(t_1)]\frac{[M_R(t_1)]^n}{n!}, \quad n = 0, 1, \ldots. \tag{4}$$

The firms that provided information from November 1986 to January 1987 were approached for a second interview after about 4 months. From this second interview we know whether the vacancy was filled in these 4 months and, if so, when the vacancy was filled. If the date at which the vacancy was filled is given by t_2 (after a duration $t_1 + t_2$), then it is easily seen that

$$g_3(t_2|t_1, n) = \theta(t_1 + t_2)\exp\left[-\int_{t_1}^{t_1+t_2}\theta(s)ds\right]. \tag{5}$$

Hence, the joint density of t_1, t_2, and $N(t_1)$ is given by the product of (4) and (5).

IV. The Data

The data were obtained by a stratified (by economic activity and number of employees) 5% random sample of all establishments in the Netherlands. Establishments with fewer than 10 employees were excluded, as were government agencies, educational institutions, and employment agencies. The original sample of 2,522 establishments resulted in a net sample of 1,913 establishments who were willing to provide the relevant information. The employers were asked whether they had at the time of the interview job vacancies for which they were searching for employees whom they wanted to put to work immediately or as soon as possible. About a third (648) of the establishments had one or more vacancies. The employers answered

questions about the required skills, the type of jobs (full-time/part-time, temporary contract or steady job, working hours, disamenities), the recruitment and selection procedures used, the elapsed duration of the vacancies, possible reasons for difficulties with filling the vacancy, and the chances long-term unemployed would have if they applied. The survey also contains information on the number of applicants, but not on their characteristics. We also do not know which wage offers (if any) were made to the applicants. Vacancies usually refer to job titles and not to individual jobs; for example, a firm may have four vacancies (jobs) for computer operators (job title). In the questionnaire, the vacancies were grouped by job title; that is, we know the number of vacancies for that particular job title, but nothing about individual vacancies. This is appropriate for most purposes. However, as a consequence we do not know the incomplete vacancy duration if there is more than one vacancy for a particular job title. For this reason we exclude job titles with multiple vacancies. Depending on the number of job titles with vacancies, the relevant information was gathered by telephone or by an interviewer who visited the establishment. This caused some additional nonresponse (68). All interviews were conducted in November 1986–January 1987.

The 580 establishments that cooperated in the first survey were approached again in March–April 1987. Almost all (550) establishments also participated in the second survey. In this second survey data were collected on the date at which vacancies were filled (if they were filled) and on the characteristics of the individuals who were hired (skills, previously employed, or unemployed). In the second survey the information was collected by vacancy and not by job title. At the time of the second survey 2,547 of the 3,608 vacancies in the first survey (71%) were filled, 25% was still unfilled, while 4% was canceled. The reason for cancellation may be that the employers' need for a new employee has disappeared (because of a changing economic performance or reorganization of the firm). The reason for the cancellation may also be that these vacancies were hard to fill and lasted too long. However, since only a part of the 4% may have something to do with vacancy durations, this is a rather small problem, and the canceled vacancies were excluded from the sample.

For the reasons given above, we have omitted all multiple vacancies. Our subsample consists of 670 vacancies. Of these 496 (74%) were filled at the time of the second survey. In table 1 we give some characteristics of the vacancies in our sample. If we compare the sample means in table 1 with those of a subsample of 1,850 vacancies for which we have complete and reliable information, we find that our subsample contains more commercial and fewer industry jobs and that fewer vacancies are posted at the labor exchange. These differences are due to the elimination of all multiple vacancies.

Table 1
Sample Means of Some Vacancy Characteristics

	Vacancy Filled at Second Survey ($N = 496$)	Vacancy Open at Second Survey ($N = 174$)	Total ($N = 670$)
Type of job:			
Commercial*	.48	.27	.42
Industry†	.23	.31	.26
Required education (minimal level):‡			
Lower vocational	.23	.16	.21
Intermediate vocational	.42	.36	.41
Higher vocational/university	.29	.51	.34
Required experience:			
Minimal experience (months/10)	1.45	2.08	1.62
Recruitment channels (at first interview):			
Advertisement	.59	.58	.59
Labor exchange notified	.31	.34	.31
Job characteristics:			
Psychological test	.25	.39	.29
Part-time job	.09	.05	.08
Characteristics of establishment:			
Number of employees (÷1,000)	.39	.50	.44
Personnel department	.65	.66	.65
Vacancy duration:			
Incomplete duration at first interview (months)	1.82	2.53	2.01
Number of applicants:			
Number of applicants at first interview	12.1	8.04	11.1

* Service, clerical, or commercial job, Dutch Central Bureau of Statistics (CBS) job classification codes 3, 4, 5.

† Industry job, CBS job classification codes 6, 7.

‡ Types of education (no. of years needed for graduation): lower vocational and lower-level general education (9); intermediate vocational and intermediate general education (12); and higher vocational education and university (15/18).

V. Estimation Results

A. Reduced-Form Analysis

As a first step we estimate a reduced-form model for vacancy durations. In a reduced-form model, we do not attempt to identify the arrival rate and the acceptance probability. Instead we use a proportional hazard model for the hazard of the vacancy duration distribution. The hazard is specified as

$$\theta(t \mid x, v) = \exp[\beta' x + \sum_{k=1}^{7} \lambda_k I_k(t) + v]. \tag{6}$$

In (6), time is measured in weeks, and $I_k(t), k = 1, \ldots, 7$, are time-varying dummy variables which are one in the time intervals 2–4 weeks, 1–2,

2–3, 3–4, 4–5, 5–6, 6+ months, respectively. Hence, we have a flexible, piecewise constant hazard. The heterogeneity component v follows a discrete distribution with two points of support:

$$\left.\begin{aligned} &h(v_1) = p, \\ \text{and} \\ &h(v_2) = 1 - p. \end{aligned}\right\} \qquad (7)$$

The points of support and the probability p are parameters to be estimated. We have to choose a particular normalization of the proportional hazard model in (6). We set the constant in (6) equal to zero. Moreover, we estimate v_1 and $v_2 - v_1$, and we reparameterize p as $\exp(\gamma)/[1 + \exp(\gamma)]$.

The parameters of the model, $\beta, \lambda_1, \ldots, \lambda_8, v_1, v_2 - v_1, \gamma$, are estimated by maximum likelihood. In constructing the likelihood function, we use the conditional distribution of the residual vacancy duration t_2 given the incomplete duration t_1—that is, we use the conditional density in (5). An advantage of this conditional likelihood is that we only use the residual vacancy duration, which is likely to be more accurate than the incomplete vacancy duration. Moreover, by conditioning we eliminate the unknown entry rate $q(\tau)$. However, conditioning changes the heterogeneity distribution (7). It is intuitively clear that vacancies that have been open for a long time at the time of the first interview have on average a smaller v than vacancies that were posted just before the time of the first interview. We can formalize this intuition by deriving the conditional density of v given t_1:

$$h(v_j|t_1, x) = \frac{\exp[-\Theta(t_1|x)v_j]p_j}{\sum_{k=1}^{2} \exp[-\Theta(t_1|x)v_k]p_k}, \quad j = 1, 2 \qquad (8)$$

with $p_1 = p$, $p_2 = 1 - p$, and

$$\Theta(t_1|x) = \int_0^{t_1} \theta(s|x)ds. \qquad (9)$$

Hence, we have

$$g(t_2|t_1, x) = \sum_{k=1}^{2} g(t_2|t_1, x, v_k)h(v_k|t_1, x). \qquad (10)$$

There is one further complication. For some vacancies that were filled at the time of the second interview, the exact date at which the vacancy was

filled is not known. Hence, the likelihood contribution of a vacancy can take one of three forms:

$g(t_2|t_1, x)$ if the vacancy is filled at a known date t_2,

$\int_{t_2}^{\infty} g(s|t_1, x)ds$ if the vacancy is open at t_2, the date of the second interview,

or

$\int_{0}^{t_2} g(s|t_1, x)ds$ if the vacancy is filled between zero and t_2.

The results are given in table 2. Note that few regression coefficients are significant. Vacancies for commercial jobs are filled more easily than

Table 2

Parameter Estimates of Reduced-Form Model Vacancy Hazard (Standard Errors)

	(1)	(2)
Type of job:		
Commercial	.41 (.128)	.40 (.129)
Industry	−.30 (.188)	−.33 (.193)
Required education (minimal level):		
Lower vocational	.16 (.251)	.14 (.256)
Intermediate vocational	−.19 (.260)	−.22 (.265)
Higher vocational/university	−.38 (.283)	−.40 (.288)
Required experience:		
Minimal experience (months/10)	−.11 (.042)	−.11 (.043)
Recruitment channels (at first interview):		
Advertisement	.17 (.105)	.13 (.107)
Labor exchange notified	−.090 (.118)	−.091 (.120)
Job characteristics:		
Psychological test	−.28 (.128)	−.28 (.130)
Part-time job	.023 (.192)	.019 (.193)
Characteristics of establishment:		
Number of employees (÷1,000)	−.048 (.075)	−.036 (.076)
Personnel department	.011 (.117)	−.008 (.118)
Duration effects:		
2–4 weeks	.46 (.905)	.41 (.893)
1–2 months	1.91 (.872)	1.84 (.851)
2–3 months	2.71 (.919)	2.69 (.908)
3–4 months	2.78 (.927)	2.78 (.919)
4–5 months	2.95 (.929)	2.87 (.921)
5–6 months	3.05 (.931)	3.07 (.922)
6+ months	2.59 (.930)	2.61 (.921)
Heterogeneity:		
v_1	−2.33 (.933)	−2.34 (.918)
$v_1 - v_2$	−2.80 (.396)	−2.78 (.375)
γ	−1.59 (.529)	−1.46 (.473)
Applicants:		
Number of applicants (÷10)	. . .	.032 (.014)

other vacancies. A higher level of education reduces the hazard. If the vacancy requires more experience, it is filled at a slower rate.

Could these results be expected? It is difficult to give a priori expectations of the signs of these coefficients. One can hypothesize that employers try to control the duration of a vacancy and as a consequence will be choosy in filling a vacancy for which they expect many applicants. The opposite will hold for vacancies for which they expect few applicants. If this is correct, we expect that variables that increase the arrival rate of applicants have a negative effect on the acceptance probability. Because the hazard rate is the product of the arrival rate and the acceptance probability, these effects may cancel, leaving the hazard rate (almost) unaffected. We need information on the number of applicants to disentangle the two effects.

The estimates show that there is positive duration dependence. More specifically, the hazard rate is small during the first 2 weeks, increases by 50% in the next 2 weeks, is multiplied by a factor 6.6 in the following month, and is doubled again in the subsequent period. Note also that there is strong evidence of unobserved heterogeneity. The 16% of the vacancies that correspond to v_2 have a hazard that is 1/16 of the v_1-type hazard. Neglecting this would cause a downward bias in the estimated regression coefficients (Ridder 1988).

We also estimated a reduced-form model for the number of (rejected) applicants at the date of the first interview. The likelihood is based on the conditional distribution of $N(t_1)$ given t_1. We also included unobserved heterogeneity as in (7), and we assumed that v is independent of t_1. The arrival rate of applicants is specified as

$$\mu(t \mid x, v) = \exp[\gamma' x + \sum_{k=1} J_k(t) + v], \qquad (11)$$

and the time-varying dummy variables $J_k(t)$, $k = 1, \ldots, 4$, indicate 2–4 weeks, 1–2 months, 2–3 months, and 3+ months. The results in table 3 show that the arrival rate of applicants rises with the required level of education and decreases with the required experience. Part-time jobs and jobs that have been advertised attract more applicants. Establishments with a personnel department also have more applicants. The duration dependence in the arrival rate has an interesting form. It is large during the first 2 weeks and jumps to zero after this first period to increase slightly after 2 months. This implies that almost all applicants arrive during the first 2 weeks of the vacancy. Figure 1 shows that this conclusion could have been reached by inspection of the data. This observation has implications for the estimation and interpretation of the acceptance probability and the arrival rate introduced in Section III.

Table 3
Parameter Estimates of Reduced-Form Model Applicant Arrival Rate (Standard Errors)

	Estimates
Type of job:	
Commercial	.45 (.041)
Industry	.22 (.047)
Required education (minimal level):	
Lower vocational	.53 (.102)
Intermediate vocational	.73 (.099)
Higher vocational/university	.73 (.104)
Required experience:	
Minimal experience (months/10)	−.027 (.012)
Recruitment channels (at first interview):	
Advertisement	.91 (.056)
Labor exchange notified	−.053 (.041)
Job characteristics:	
Psychological test	−.034 (.039)
Part-time job	.36 (.052)
Characteristics of establishment:	
Number of employees (÷1,000)	−.057 (.027)
Personnel department	.51 (.039)
Duration effects:	
2–4 weeks	−6.76 (3.04)
1–2 months	−5.48 (2.45)
2–3 months	−4.09 (1.56)
3+ months	−3.01 (.183)
Heterogeneity:	
v_1	.68 (.108)
$v_2 - v_1$	−1.89 (.029)
γ	−1.15 (.096)

B. Estimates of Arrival Rates and Acceptance Probabilities

In Section III we implicitly assumed that the applicants arrived sequentially and that they were screened at the time of arrival; that is, the employer accepted or rejected the applicant instantaneously. However, applicants may not arrive sequentially, and screening usually takes time. To be specific, we assume that after announcing the vacancy the employer takes an application period T to form a pool of applicants. Next, the employer screens these applicants and selects an employee. Let us assume that it takes a selection period S to select the best applicant from the pool of applicants. If employers use this strategy, then we expect that the arrival rate of applicants is large during the first weeks of the vacancy, that is, during the application period T. Moreover, the acceptance probability is small because it takes time to screen the applicants. In the subsequent weeks the arrival rate of applicants becomes small, and the vacancy hazard reflects the speed of selection of an employee from the pool of applicants.

This interpretation is in line with the estimates of the duration dependence in the vacancy hazard and the arrival rate of (rejected) applicants: the rate at which applicants are hired is small during the first 4 weeks, and

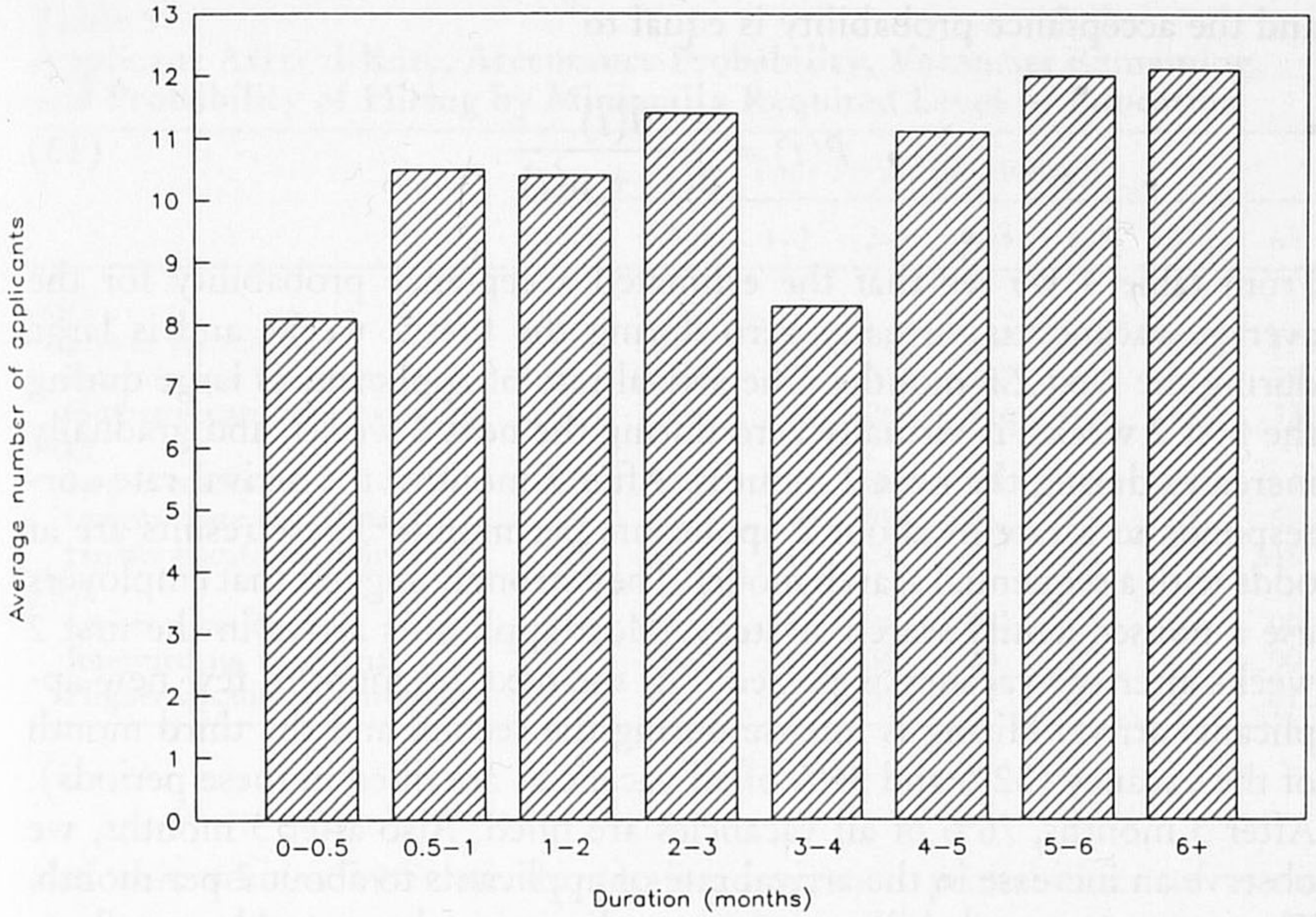

FIG. 1.—Number of applicants at first interview by incomplete vacancy duration

the arrival rate of applicants becomes small after the first 2 weeks. In table 4 we give these rates for the average vacancy, that is, for the vacancy with the average characteristics of table 1. To see the implications for the estimation of the duration dependence, we note that the arrival rate of applicants in the model of Section III is equal to

$$m(t) = \theta(t) + \mu(t), \tag{12}$$

Table 4
Vacancy Hazard and Arrival Rate of Rejected Applicants of "Average" Vacancy; Implied Acceptance Probability, Applicant Arrival Rate, Fraction of Vacancies Remaining, and Probability of Hiring

Time period	$\theta(t)$	$\mu(t)$	$P(t)$	$m(t)$	$S(t)^*$	$f(t)$†
0–2 weeks	.0163	3.89	.004	3.91	. . .	.03
2–4 weeks	.0258	.00451	.85	.0303	.97	.05
1–2 months	.107	.0162	.87	.123	.92	.32
2–3 months	.233	.0651	.87	.298	.60	.36
3–4 months	.250	.192	.57	.442	.24	.15
4–5 months	.268	.192	.58	.460	.09	.06
5–6 months	.327	.192	.63	.519	.03	.02
6+ months	.205	.192	.52	.397	.01	.01

* Fraction of "average" vacancies remaining in indicated period.
† Fraction of "average" vacancies filled in indicated period.

and the acceptance probability is equal to

$$P(t) = \frac{\theta(t)}{\theta(t) + \mu(t)}. \tag{13}$$

From table 4 we see that the estimated acceptance probability for the average vacancy is virtually zero during the first 2 weeks and is large during the next 2.5 months. The arrival rate of applicants is large during the first 2 weeks, is virtually zero during the next 2 weeks, and gradually increases during the next 2 months. After 3 months, the arrival rate corresponds to a rate of about 2 applicants per month. These results are at odds with a sequential search model. They strongly suggest that employers use a nonsequential search strategy. Most applicants arrive in the first 2 weeks after the vacancy is posted. For the next 2.5 months, few new applicants arrive. Hiring is intense during the second and the third month of the vacancy (32% and 36% of all vacancies are filled in these periods). After 3 months, 76% of all vacancies are filled. Also after 3 months, we observe an increase in the arrival rate of applicants to about 2 per month. The acceptance probability of these applicants is about .6. Almost all vacancies are filled by the fifth month.

We conclude that 76% of all vacancies are filled by applicants who arrived during an application period that lasts for about 2 weeks. The estimates also suggest that it takes 1–2 months to select a suitable new employee from the pool of applicants. The other 24% of the vacancies may be filled using a sequential search strategy. The relatively high acceptance probability guarantees that almost all vacancies are filled after 5 months.

In table 5 we distinguish vacancies by the level of education that is required by the employers. Broadly the same picture emerges as for the average vacancy. Note that only 10% of all vacancies that require a lower vocational training are filled after the third month. This fraction is 20% and 28% for vacancies that require an intermediate or higher level of education. Note also that the initial pool of applicants is larger for vacancies that require a higher level of education. However, it takes more time to select an employee from this pool. The acceptance probabilities show that, the higher the required level of education, the smaller the fraction is of acceptable applicants after 3 months. These results suggest that at the lower level employers need relatively little time to hire an applicant from a relatively small initial pool and that almost all employees are hired from this pool. At the higher educational level, employers need more time to select an employee from a larger pool of applicants. Fewer employees are hired from this pool, which may be caused by relatively high standards in the evaluation of applicants at higher educational levels. These high standards are also used in evaluating applicants that arrive after the first 3 months,

Table 5
Applicant Arrival Rate, Acceptance Probability, Vacancies Remaining, and Probability of Hiring by Minimally Required Level of Education

	Time Period (in Months)							
	0–0.5	0.5–1	1–2	2–3	3–4	4–5	5–6	6+
$m(t)$:								
Lower vocational	3.44	.0401	.168	.400	.537	.605	.650	.473
Intermediate vocational	4.19	.0305	.126	.313	.467	.479	.511	.385
Higher vocational/university	4.18	.0254	.105	.265	.416	.454	.480	.379
$P(t)$:								
Lower vocational	.007	.90	.92	.86	.69	.72	.74	.64
Intermediate vocational	.004	.84	.87	.78	.46	.65	.67	.56
Higher vocational/university	.003	.81	.84	.74	.50	.55	.57	.46
$f(t)$:								
Lower vocational	.04	.07	.43	.36	.08	.02	.00	.00
Intermediate vocational	.03	.05	.34	.38	.13	.05	.02	.00
Higher vocational/university	.03	.03	.30	.36	.17	.07	.03	.01

and this results in relatively small acceptance probabilities of these applicants.

Most empirical research of the search behavior of the unemployed suggests that unemployment is due to lack of job offers. Our results show that vacancies are not the result of a lack of applicants. Most vacancies are filled within 2.5 months after the arrival of a pool of applicants during the first 2 weeks of the vacancy. Hence, if we divide a vacancy duration into an application period and a selection period, then the employer spends most of the duration on selection. If we thus reconsider the estimates of table 2, we conclude that the selection period for commercial vacancies is relatively short and that it takes more time to select a suitable employee if the required work experience is large and if the selection procedure includes a psychological test. From the second column of table 2, we see that the length of the selection period decreases with the number of applicants—that is, it takes less time to select an employee from a large pool of applicants than it takes to select an employee from a small pool of applicants. Because we have included a number of regressors that affect the number of applicants (see table 3), we can interpret the coefficient as the effect of a deviation between the expected and the realized number of applicants. If the number of applicants is smaller than expected, the employer may resort to sequential search, which takes more time. Without information on the date of arrival of the successful applicant, we cannot investigate this possibility. However, this effect may explain the procyclical variation of the vacancy duration as documented in van Ours and Ridder (1991*a*). In periods of high unemployment, the large number of applicants reduces the average vacancy duration, and the opposite holds in periods of low unemployment.

Note that we can also reinterpret the estimates in table 3. The Poisson model estimated in that table can be seen as a Poisson regression for the size of the initial pool of applicants.

VI. Conclusion

It is tempting to treat unemployment and vacancies symmetrically: the unemployed are looking for a job, and firms with one or more vacancies are looking for employees. Our results show that search by the unemployed is different from search by firms. Employer search is mostly nonsequential. Employers advertise a vacancy and thereby form a pool of applicants. Almost all applicants arrive during the first 2 weeks after the announcement of the vacancy, and most vacancies are filled within the next 2.5 months, a period during which few new applicants arrive. After that period, employers may resort to sequential search, but our data are not conclusive in this respect. Hence, most vacancies do not exist because there are no applicants, but because it takes time to select a suitable employee from the available applicants. In other words, vacancy durations are mostly selection periods, and modeling vacancy durations means modeling the selection of an employee from a pool of heterogeneous applicants. In a companion paper (van Ours and Ridder 1991*b*) we pursue this point. More specifically, we study the role of job requirements in the selection process.

In this article, we find that selection from a (unexpectedly) large pool of applicants is easier than selection from a (unexpectedly) small pool. Hence, if a given number of unemployed individuals searches with a low intensity, we shall see few applicants and long selection periods (vacancy durations). This is in line with the finding of Jackman et al. (1989) that the average vacancy duration has increased for a given level of unemployment (duration) because the unemployed search with a lower intensity. An alternative explanation is that employers now find it more difficult to select a suitable employee from the same number of applicants as before because jobs have become more specialized. Without knowledge of the cyclical variation of the number of applicants, we cannot distinguish between these hypotheses.

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